Instruction in High Schools: The Evidence and the Challenge

Tom Corcoran and Megan Silander

Summary

The combined effects of standards-based reforms and accountability demands arising from recent technological and economic changes, say Tom Corcoran and Megan Silander, are requiring high schools to accomplish something they have never been required to do—ensure that substantially all students achieve at a relatively high level. Meeting that challenge, say the authors, will require high schools to improve the effectiveness of their core technology—instruction.

The authors first examine how organizational structures affect instruction. Most high schools, they say, organize instruction by subject or discipline, thus encouraging an isolated and independent approach to teaching rather than one in which teachers are guided by a shared vision or goals. Many schools have focused on increasing teacher collaboration, often through teaming, interdisciplinary teaching, or professional learning communities. Citing limited evidence that these reforms improve instruction and learning, Corcoran and Silander urge researchers to examine whether the changes help schools implement specific instructional reforms and support sustained efforts to improve instruction.

Next the authors explore the effects on student learning of instructional strategies such as interdisciplinary teaching, cooperative learning, project-based learning, adaptive instruction, inquiry, and dialogic teaching. The evidence suggests the power of well-designed student grouping strategies, of allowing students to express their ideas and questions, and of offering students challenging tasks. But, the authors say, less than half of American high school students report working in groups, and little class time is devoted to student-centered discussions.

The authors conclude that schools should promote the use of proven instructional practices. In addition, teachers should systematically monitor how students vary in what they are learning and adapt their instruction in response to students' progress and needs, in the process learning more about what variations in instruction respond most effectively to common variations in students' learning. The authors argue that such "adaptive instruction" has the greatest potential for success in today's standards-based policy environment with its twin values of equity and excellence.

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The American high school is often characterized by reformers as a failing institution, a place in which teaching is teacher-centered, boring, and impersonal, where students are expected to master a fragmented curriculum disconnected from the world outside the school, where too many students fail to graduate and many others graduate lacking skills essential for success in college or the workplace. Is this a fair portrayal of American high schools at the beginning of the twenty-first century? We want to say right off that in our view it is not. While it is true that national graduation rates and scores on the National Assessment of Educational Progress have been stagnant for decades and that there are too many weak, bureaucratic, and impersonal high schools, there are many more that offer good teaching and engaging and relevant programs, and even some that have made dramatic improvements in student performance in recent decades.[1] In most communities in the nation, parents, students, community leaders, and policy makers are happy with their local high schools and believe their schools are changing to keep pace with the demands of the twenty-first century. Forty-seven percent of those surveyed in 2007 in the Phi Delta Kappa/Gallup poll gave their local high schools an A or a B, up from 32 percent in 1981.[2] The images of alienation, stagnation, and failure so often portrayed in the media arise primarily from a focus on the large, under-resourced schools characteristic of the nation's inner cities and older suburbs, and here the situation is alarming enough that calls for action are being heard from all quarters.

The performance of many of the high schools serving low-income and minority students has been dismal at best, and pressure from school reformers, policy makers, business leaders, and the public for significant improvement of these schools has built to a crescendo. Rising academic expectations, however, are posing unique challenges for the nation's high schools regardless of whom they serve because of the widespread belief that the curriculum for all students should be more challenging. Most states have raised their course requirements for graduation at least once over the past twenty years, and many have adopted graduation tests. Now state policy makers are considering raising the bar once again. Some are reviewing their standards. Others are making their graduation tests tougher. Some have begun to specify the content to be covered in high school courses. But at the same time that high schools are being asked to offer more rigorous preparation for larger numbers of students, they are also being asked to ensure that all or almost all students meet rising academic standards and that dropout rates decline.

To meet these challenges, high schools will have to improve the effectiveness of their core technology—instruction. As conventionally used, the term "instruction" focuses solely on teacher behavior and is defined as a formal act of helping someone learn a skill or acquire new knowledge. We take a broader view, following David Cohen and Deborah Ball and others, who define instruction as the interactions between teachers and students around curriculum content,[3] and James Hiebert and Douglas Grouws, who modify this definition by focusing as well on learning goals.[4] We define instruction as the interactions between teachers, students, and content directed toward helping students achieve learning goals. Instruction is a narrower concept than "teaching," which includes such responsibilities as guidance, supervision of students (in loco parentis), and curriculum development.

Some argue that it is difficult to improve instruction in high schools and support their argument by contending that instruction in high schools has not changed much in recent decades. But in fact it has changed a great deal. Among the many instructional reforms that have swept through the nation's schools are reductions in tracking (the grouping of students in classes by their prior achievement or measures of academic potential), mainstreaming of special education students, increased use of technology, increased focus on measured outcomes as a result of new state assessments and graduation examinations, the introduction of block scheduling to provide more time for student work and investigations, and the expansion of participation in Advanced Placement courses. Yet it seems to be true that the basic patterns of classroom interactions between teachers and students have remained relatively stable.[5]

What is it about instruction that most influences student learning? What changes should educators be trying to make to the instruction offered in high schools? Does research offer guidance about how to make instruction more effective? Answering these questions would help high school faculties meet the challenges they face. Because other articles in this volume focus on two of the three key components of instruction—students and curriculum—we emphasize in this article the contributions of teachers and their instructional approaches to student learning. Although it is not possible to discuss what teachers do instructionally without touching on their interactions with students and content, our focus is on how teachers can improve their work and contribute to a school's capacity to offer good instruction.

We address two central topics—the organization of instruction in high schools and the effectiveness of various instructional methods—and explore what researchers know, or don't know, about how each affects learning. First we examine the evidence concerning how different organizational structures affect instruction, and then we turn to the evidence about the efficacy of various instructional strategies. Finally, we consider the implications for instruction of standards-based reforms and the demands for higher levels of performance.

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In each case, we examine the quality of the research evidence, highlight the major findings, and consider the warrant the evidence provides for taking action. We identify the gaps in the knowledge base concerning high school teaching, and we conclude by discussing the issues raised by the research evidence with regard to improving teaching, including issues of equity and the impact of current policies.

How Is Instruction Organized in High Schools?

In most of the nation's high schools, instruction is organized by subject or discipline. Most teachers spend each day independently teaching topics in one content area, such as English, mathematics, science, and history, to

groups of twenty-five to thirty-five students for forty-five to sixty minutes at a time, working with from one hundred to one hundred and eighty different students over the course of a week. Work outside the classroom is also highly compartmentalized, with teachers organized into departments by their subject matter specialty.[6] These prevailing norms reinforce an isolated and independent approach to teaching in high school classrooms. The technical core of instruction often seems to be only loosely coupled to institutional goals and demands, and the prevailing norm is that the larger organizational structures of the school should not interfere with the autonomy of the teacher.[7]

But researchers examining how instruction is organized have found that organizational structure often, although not necessarily intentionally or consistently, does affect instruction in meaningful ways.[8] And, in fact, some educational reform strategies employ structural changes to try to improve instruction, particularly by reorganizing large comprehensive high schools into smaller, more focused learning communities or teacher teams. Implicit in these reform efforts is the idea that the new organizational structures will affect the relationships among teachers and between teachers and students and that these new relationships will alter the ways in which high school teachers teach and students learn.

The Roles of Departments and Teams

Two of the most common and persistent features of high schools are the division of instruction into specific disciplines and the corresponding organization of teachers into departments by academic disciplines.[9] The resulting organizational structure shapes assignments of teachers to various courses and categories of students. It also affects teachers' opportunities for support and collaboration, the norms governing their professional responsibilities and instructional practice, the content and focus of their professional development opportunities, and the nature and strength of their professional commitments.[10]

Until the 1990s, the role of departments, almost universal in the structure of high schools, remained relatively unexamined.[11] In recent years, however, researchers have begun investigating the role and strength of departments and their influence on teachers' work lives and classroom practices.[12] Studies have found, for example, that strong departments can increase teachers' opportunities for collaboration or innovation and for sharing and dissemination of practices. Strong departments can also foster the development of shared internal accountability norms for teacher and student performance. But they can also be associated with maintenance of the status quo, the use of narrower and fragmented curricula, low expectations of students, and resistance to changes in instruction.[13]

Leslie Siskin provides a particularly compelling story of subject departments through case studies based on three years of observing three comprehensive public high schools.[14] The academic departments in these high schools varied in their strength and salience, and they differed both in their social cohesiveness and in their commitment to a common purpose. Most, however, ranked high in cohesiveness but low in commitment to a common purpose. Affiliation was the glue that held them together, not the possibility of higher achievement. Their members focused more on their individual interests than on collective goals. Department members might share resources, eat lunch together, and

discuss common students, but they taught according to their personal styles and preferences rather than being guided by any shared vision or goals. In addition to forming social worlds for teachers, these departments allocated and distributed resources. They also made decisions about textbook selection, equipment, tracking policies, and teacher assignments to courses—often basing those decisions on teachers' seniority or training rather than on their instructional effectiveness. Siskin's study suggests that departments with high levels of social cohesion and commitment to common goals and purposes can be powerful mechanisms for establishing shared norms and goals for instruction. But in most of the departments that Siskin examined, instruction was influenced by the department context only when individual teachers chose to seek out and use the resources and instructional strategies of their colleagues.[15] Still, the salience of the department as a place for teachers to interact suggests that efforts to improve instructional approaches should take into account their role and its variation within and between schools. For example, when schools have strong departments, designers of instructional improvement initiatives might wisely strengthen the role of department leaders and build their expertise about instruction and coaching.

The organization of departments by subject matter also shapes instructional strategies by reinforcing understandings and beliefs about instruction and learning commonly associated with specific disciplines. Susan Stodolsky and Pamela Grossman, for example, examined how teachers' conceptions of their subject matter affected their curricular activities.[16] The study, based on teacher survey data from approximately 400 teachers in sixteen private and public high schools in California and Michigan, found significant differences by discipline in whether teachers perceived their subjects as defined, static, or sequential. Teachers of mathematics and foreign languages, for example, were much more likely than English, science, and social studies teachers to perceive their subjects as sequential, static, and defined. The way teachers perceived their subject was associated with differential decisions about course content, sequence, and pacing, as well as their views and practices regarding the curriculum. For example, social studies teachers, who were less likely to consider their subjects "well-defined," were also least likely to report department agreement about course content and less likely to report developing curricula together with other teachers. Mathematics teachers, most likely to perceive their subject as static and unchanging, were more likely to agree that they "follow the same teacher routines every day."[17] Teachers' beliefs about student tracking—grouping students by prior achievement—also differed by discipline. Mathematics teachers, who were most likely to perceive their subjects as sequential, were also most likely to agree that instruction was most effective when students were grouped by past academic achievement, while social studies teachers were least likely to agree.[18] The researchers did not observe directly how these differences in perceptions affected classroom instruction, although it seems likely that they would.

Within disciplines, teachers' beliefs and practices about curriculum varied as well, suggesting that subject "subcultures" might shape some beliefs and instructional practices without systematically determining them. The primary lesson of these studies is that taking into account common subject-based perspectives on content and pedagogy, and identifying how differences in underlying

conceptions of subject matter relate to and interact with conceptions of good instruction, might enhance the effectiveness of instructional improvement initiatives.

Teacher Teaming

Some reformers aiming to improve instruction have focused on team teaching. Teaming can range from having two teachers work together to plan instruction to making small groups of interdisciplinary or grade-level teachers responsible for a subset of students within a school, working together to plan group activities or even interdisciplinary units of instruction.[19] Teaming first became popular in middle schools and has since been adopted by some high schools. The underlying assumption of these reforms is that creating small teams of teachers or work groups will foster more collegial environments, more opportunities for teacher collaboration and knowledge sharing, better coordination of instructional efforts, greater involvement in instructional decisions, and higher staff morale and job satisfaction.[20] Teacher teaming rests on the same theories that underlie the adoption of autonomous work groups in industry and public sector institutions. It can also serve as a governance reform, providing teachers more opportunities to participate in school management under the supposition that increased self-management will lead to greater job satisfaction, responsibility, and commitment, and thus less teacher turnover, greater work effort, and better student outcomes. In the private sector, similar approaches have found that flatter hierarchical structures allow for more creativity and innovation.[21] But empirical evidence on the relationship between teaming and student learning is limited to small case studies, usually conducted in elementary and middle schools, that tend to focus on team functioning and other mediating factors rather than changes in instructional practice or student learning. What evidence there is suggests that teacher teaming may facilitate changes in instructional strategies and discussions of students' learning that might lead to improved student outcomes. The lack of rigorous evidence that teaming has systematic effects on student achievement means that researchers do not yet know if these reforms pay off.

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For example, one study examined a K–12 teacher teaming reform in the Cincinnati Public Schools in which teachers were organized into teams of three to five core academic subject teachers who remained with the same group of students over two years. In addition to teacher teaming, the reforms included a more focused curriculum, new instructional methods and materials, and increased professional development opportunities. Findings from this study, although limited to elementary and middle schools, showed that overall, compared with student performance in similar schools that did not team teachers, teaming did not improve student test scores. But the effects varied by the type of work in which the teacher teams engaged. Teams that focused on the relationship between instruction and student work made greater student learning gains, while

teams that worked together but did not focus on instructional practice did not.[22] The study suggests that teaming can contribute to improved instruction and higher performance but only if the work of the teams is focused on these outcomes.

More empirical evidence is available on the effectiveness of teaming in other public sector institutions. For example, a meta-analysis of experimental and quasi-experimental empirical research on health-care delivery suggests that team care can lead to better clinical outcomes than can non-team care and that larger, more diverse teams tend to be especially effective.[23] Some of these findings are likely applicable to education as well. It is clear, however, that the context within which teams work can affect their effectiveness. Indeed, the research review found that team effectiveness varied by context and discipline and that organizational characteristics, such as leaders' focus on quality improvement, the length of time teams worked together, the physical proximity of team members, and deeply rooted institutional norms about practice, affected the efficacy of teaming.[24] This evidence offers lessons for education, where norms of teacher autonomy and disciplinary differences in beliefs about teaching and learning might prove to be barriers to the effective use of teams in some schools.

Professional Learning Communities

Reformers have also tried to increase teacher collaboration and learning by establishing professional learning communities within departments or grades, across a school, or across disciplines outside of schools. Definitions of professional learning communities vary, but all aim to increase teacher collaboration to build teachers' knowledge about students and about teaching and learning, to encourage teachers to share resources, and to create shared norms and views about teaching and learning practices.[25]

Although not focused specifically on professional learning communities, a study by Valerie Lee and Julia Smith, using data from the National Education Longitudinal Study of 1988, examined the relationship between student achievement and teachers' cooperation and collective responsibility for student learning. Looking at student gains in achievement from eighth to tenth grade in math, reading, history, and science, and controlling for student demographics and prior achievement and school demographics, Lee and Smith found a positive link between student learning and both teacher cooperation and collective responsibility for student learning. Because the study is cross-sectional, a snapshot in time, and not conducted over multiple years, it is impossible to conclude that reforms to increase collaboration and collective responsibility for student learning necessarily would affect student learning. The authors themselves suggest that teachers' beliefs about the limitations of students' ability to learn—a key component in the collective responsibility factor—may not be mutable.[26] It also may be that working in schools in which students are making progress leads to stronger feelings of collective responsibility and willingness to collaborate among teachers. Moreover, other research, such as Andy Hargreaves' study of "contrived collegiality," suggests that compulsory teacher collaboration can be less effective than collaborative relationships that evolve naturally from within a teacher community.[27]

Small learning communities (SLCs) of teachers *and* students are a variation on professional learning communities. SLCs can be developed in newly created small schools or in large high schools that are divided into smaller communities. They can take multiple

forms, ranging from partial models such as ninth-grade academies and vocational or career academies within existing comprehensive high schools to full wall-to-wall models in which all faculty and students in a building are part of one or more SLCs.[28]

The rationale for creating both smaller schools and SLCs is that smaller groups of teachers and students will form stronger communities. As a consequence, teachers will provide better guidance and more personal attention for students, and student-teacher relationships will be stronger, resulting in fewer disciplinary problems and safer school environments. Advocates also claim that SLCs will lead to increased teacher empowerment, leadership, and collaboration within and across disciplines, as well as a more efficient administration and a more responsive and focused curriculum.[29]

The article by Steve Fleischman and Jessica Heppen in this volume surveys research on small schools and small learning communities in depth, so here we simply summarize the empirical research. Researchers have found that free-standing small schools have higher rates of attendance, more positive climates and fewer disciplinary problems, and higher retention and graduation rates, but the evidence of effects on student academic outcomes is mixed.[30] The findings from research specifically examining small learning communities and schools within schools are even more mixed, and although they suggest that SLCs can lead to higher academic achievement, the effects seem to be modest and varied.[31] Moreover, restructuring large schools into smaller communities often results in greater stratification of student outcomes by race and ethnicity, class, gender, special education status, academic achievement, and behavior.[32]

The evaluation of a Gates Foundation initiative to establish new small schools and redesign comprehensive high schools into small learning communities found mixed and modest academic effects, with higher student achievement gains in reading than in mathematics. The evaluation also examined instructional methods and found that teachers in the Gates-funded schools were more likely to assign students work relevant to the real world and that assignments tended to be more rigorous in those schools for English, but not for mathematics. Effects on school culture were more uniformly positive: students had higher attendance rates, and both teachers and students reported better school climates, including more personalization and shared goals and focus.[33]

Interdisciplinary Teaching

Despite the apparent primacy of the disciplines in high schools, some reform efforts have attempted to blur the boundaries among subjects, seeking to help students make stronger connections across different domains of knowledge. Research on interdisciplinary teaching is not extensive, particularly at the high school level, and there is no experimental evidence or even quasi-experimental evidence—that is, a research design in which the experimental and comparison, or control, groups are not randomly assigned—to support contentions that interdisciplinary teaching produces different or better outcomes. Further, the body of research is difficult to summarize given the differing conceptions and approaches to interdisciplinary curriculum.

One review of studies of interdisciplinary programs and teaching found that most focused on integrating English and social studies.[34] Researchers found that integrating instruction in these two disciplines increased

the amount of student writing and the use of original texts in classes. For example, an evaluation of an integrated social science and literature program in Los Angeles schools found that students in the program had more writing assignments, that their writing was higher in quality and revealed greater conceptual understanding, and that teachers had higher expectations of students in the program than they did of students not in the program.[35]

A more recent study by Arthur Applebee, Mary Adler, and Sheila Flihan used an ethnographic case study approach to examine the curricula and teaching practices of thirty seventh- through eleventh-grade teachers serving on eleven interdisciplinary teams in New York and California. The study found that their interdisciplinary efforts fell into several categories along a continuum: correlated curricula in which the two disciplines followed parallel lines chronologically or by region; shared curricula in which major concepts were taught across disciplines; and reconstructed curricula in which understandings and concepts were merged across disciplines.[36] The finding suggests that organizing instruction by integrating disciplines does not necessarily result in *systemic* changes to instruction. Barriers to interdisciplinary instruction identified in this and other studies included the extra time and effort required of teachers as well as conflicting beliefs across disciplines about subject matter and the ways in which subject matter should be taught.[37]

Do New Organizational Forms Improve Teaching and Learning?

In summary, the empirical evidence suggests that changes in the way teachers' work is organized can affect student learning, but only when reforms give explicit attention to instruction. The most promising evidence—though based largely on qualitative cross-sectional studies—relates to the potential efficacy of teacher teaming and professional learning communities and the opportunities they provide for teachers to share and build knowledge about individual students and about teaching and learning. Researchers should examine whether these new organizational forms make it easier for schools to implement specific instructional reforms and whether they lead to sustained efforts to improve instruction.

Instructional Approaches

Does it matter how teachers teach? Is there persuasive evidence about "best practices" that can help students learn more and achieve deeper understanding of the curriculum content? Or is good teaching idiosyncratic to the individual teacher, dependent on the educator's philosophy, personality, general intelligence, and subject matter knowledge? Here again we take the broader view of instruction put forth by Cohen and Ball, and use "instructional approaches" as our unit of analysis.[38] An instructional approach is characterized by certain regularities in the ways in which teachers and students interact with each other and with instructional materials that can be described, evaluated, and replicated. Among the instructional approaches used by teachers in various disciplines in high schools are interdisciplinary teaching, student teaming or cooperative learning, project-based learning, adaptive instruction, inquiry, and dialogic teaching. We have already discussed interdisciplinary teaching and the evidence on its effectiveness; we next define and discuss the others. While each has ardent advocates, they overlap and can be combined. Project-based learning, for example, typically involves teaming, although the reverse is not necessarily true, and dialogic teaching can be combined with adaptive instruction or inquiry.

Nevertheless, each approach represents a distinctive pattern of interaction among teachers, students, and instructional materials, and it is possible to study the effects of each on student learning. We look first at cooperative learning or teaming and project-based learning. For inquiry, dialogic teaching, and adaptive instruction, we examine research on what has been found to work in one or more of three key components of the high school curriculum: language arts and writing, mathematics, and science.

A highly effective instructional approach or "best practice" is one that results in measurable improvements in performance on examinations or standardized tests. In a broader review we would also consider outcomes such as student engagement, effort, persistence, and subsequent success in the subject and in academic work generally. In this short review we cannot consider all the evidence bearing on multiple outcomes, nor can we systematically review the findings from the thousands of studies, largely small in scale, examining the effectiveness of particular pedagogies. Instead we rely heavily on reviews prepared by others to determine whether there is compelling evidence to support the general hypothesis that the specific instructional approaches used by teachers matter and affect student achievement.

Group Learning

Popularly known as cooperative learning after one well-known variant of this approach, student groups or teams are used by many high school teachers. But although this instructional approach is familiar to many teachers and its use is not rare, it remains the exception in high school classrooms. And when it is used, it is often used carelessly, with too little regard to the composition of the groups, the appropriateness of the tasks they are assigned, or the assessment of their work. Effective use of cooperative groups requires attention to these details and training for both the teachers and the students.[39]

Numerous research reviews have concluded that using various forms of group learning or teaming has improved pupil achievement, social attitudes such as tolerance and acceptance of differences, and classroom climates.[40] The studies examined in these reviews typically used experimental designs to look at the effects of structured classroom grouping on student learning, behavior, and attitudes. Researchers carrying out the experiments placed students randomly into grouped and non-grouped classrooms and collected observational and survey data to examine the effects of the grouping strategy on standardized measures of achievement. In one review, Peter Kutnik and several colleagues note some shortcomings of these meta-analyses—namely, that they do not attend sufficiently to differences in curriculum and tasks and to variations in effects across age groups.[41] Kutnik and his colleagues also point out that these grouping programs may not always fit well with classroom realities and therefore may be hard for some teachers to implement and sustain. They contend that researchers should give more attention to how both teachers and students are prepared for this kind of instruction and how class size, group composition, seating arrangements, group stability, the number of groups, and other factors influence the effectiveness of this approach. They also present a general theory of grouping that they believe provides teachers with more guidance and more flexibility than many of the current externally designed grouping programs.

Despite these caveats, the evidence shows that using structured student groups is a

promising instructional approach. Many independent reviews show that student teams improve student achievement. The effects are so large and so consistent across subjects that group learning would be normative in an evidence-based environment. We shall return to this theme.

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Project-Based Learning

Project-based learning (PBL) organizes instruction around student-generated and -managed projects. It emerges from three older traditions of teaching: experiential and problem-based learning, which has been used successfully in higher education for decades; the Outward Bound wilderness expeditions; and the application of research on motivation, expertise, context, and technology to the design of instructional programs. Definitions of project-based learning vary widely, including the degree to which the approach must be student-centered.[42] The variations make it somewhat hard to do research on PBL and also hard to summarize research findings, as the latter task requires deciding both what the parameters of PBL should be (do packaged or scripted projects count?) and whether the differences observed in variations of PBL matter and how they matter. There is general agreement, however, that the student projects should be central to the curriculum and focused on questions that direct students to encounter central concepts in a discipline. Most advocates believe the projects should not be teacher-selected or -scripted; rather, the students should have some choice and be expected to design and carry out the project themselves over an extended period of time. Significant portions of the work should be done independently, though the students often work in teams and the teacher may offer advice and guidance and feedback on partially completed or draft products. The projects should be realistic, not academic.[43]

PBL is often used in technology classes and is often supported by technology when used in other disciplines. The approach is used in many of the small schools funded by the Gates Foundation, such as those developed by Envision Schools and Big Picture Schools, in schools adopting the Expeditionary Learning and Co-nect school designs, and in many schools involved in technology projects. These schools all share a basic instructional approach, with considerable variation in the specifics.

The research on PBL consists largely of small-sample, non-experimental studies.[44] Most rely on observations and interviews of students and teachers. Some use surveys. Although the findings suggest that participating in PBL increases student motivation and engagement, reduces absenteeism, strengthens cooperative behavior and improves higher-order thinking skills, the methodologies employed typically do not support such causal inferences. A series of studies of the Expeditionary Learning/Outward Bound (ELOB) and Co-nect school designs reported modest but significant gains in academic

outcomes and changes in school climate.[45] A more recent analysis of the effectiveness of comprehensive school reform designs found the research evidence for ELOB to be promising while indicating the need for more research on Co-nect.[46] A review conducted in 2006 found only limited evidence that ELOB was effective and did not rate Co-nect.[47]

Although teaming, project-based learning, and interdisciplinary teaching are used in many subjects, the specifics of instruction usually are closely connected to curriculum content. That is, the pedagogies used in mathematics differ somewhat from those used in science or in language arts. Therefore, much of the research on instruction has been domain-specific, and evidence about instruction is typically examined domain by domain. We follow the pattern here and examine the evidence about instructional effectiveness in mathematics, science, and language arts below.

Mathematics

The effectiveness of various instructional approaches in mathematics has been heavily debated in recent years without much regard to empirical evidence about what works. Simply put, traditionalists, led by some respected mathematicians, and progressives have disagreed, among other things, over whether school mathematics should place more emphasis on algorithms (procedures for solving problems) or concepts, and whether discovery (constructivist methods) or direct instruction is more appropriate and effective and for whom. In 2005, representatives of the two groups issued a manifesto called "Reaching for Common Ground" to try to resolve some of their apparent differences over content and pedagogy.[48] In the manifesto, leaders from the two groups agreed on three fundamental premises: students need proficiency with computational procedures, students must develop the ability to reason using mathematical language with precision, and students must be able to formulate and solve problems. They also agreed that automatic recall of certain basic procedures and algorithms was desirable, that calculators could be useful but should be used carefully in order not to impede fluency with basic procedures, that students should understand and be able to use basic whole-number algorithms and fractions fluently, that teachers should use methods appropriate to the goals, and that teachers should understand the mathematics they teach and how to make mathematics accessible to students.[49]

However, the debates continue, and evidence from a rich body of research on mathematics education does not resolve them. Most studies of mathematics teaching are small in scale, and many are observational, although some are small experimental and quasi-experimental studies. And most of the research has focused on the elementary and middle grades. Reviewing all this research would be beyond the scope of this article, but, fortunately, excellent reviews have been conducted in recent years.[50] The reviews tend to agree that the practice of American mathematics teachers is not in line with the vision of reformers who want to see more emphasis placed on conceptual understanding and more student-centered and hands-on pedagogy in mathematics classrooms. In spite of decades of professional development and introduction of more constructivist curricula, the IRE (initiation-response-evaluation) pattern of teacher-student interaction prevails. The reviewers also note the lack of well-developed pedagogical theory to guide research and methodological difficulties associated with linking specific practices to student learning. Nevertheless, the reviewers

see patterns in the research evidence suggesting the importance of teaching mathematical concepts explicitly, regular opportunities for student discussion, and collaborative work by students. Megan Franke, Elham Kazemi, and Daniel Battey point out that "simply using manipulatives, putting students in cooperative groups, or asking higher order questions does not lead to classrooms that support the development of mathematical understanding. How teachers and students engage with higher order questions, engage students in groups, or use manipulatives matters."[51]

These recent research reviews also emphasize the importance of discourse in mathematics classrooms. They cite many small studies that report that open discourse helps teachers understand their students' mathematical thinking and that when students have opportunities to express their ideas, they develop greater understanding. Franke and her colleagues describe four key strategies for effective discourse: revoicing, assigning worthwhile tasks, having students participate, and interrogating meaning. These strategies, of course, have been found to be components of most effective instructional approaches.[52] Again, most of this research has been conducted in elementary or middle schools, and its implications for high school teaching are not clear.

As James Hiebert and Douglas Grouws point out, the empirical links between particular patterns of discourse and student learning have not been established.[53] They note the primacy of two learning goals in mathematics—teaching skill efficiency or fluency and teaching conceptual understanding—and note there are no empirical studies that set out to examine which instructional approaches are associated with which of these outcomes. They argue that some features of instruction emphasize one and some the other, but that they overlap. Reviewing the process-product research, they conclude that "teaching that facilitates skill efficiency is rapid-paced, includes teacher modeling with many teacher-directed product-type questions, and displays a smooth transition from demonstration to substantial amounts of error-free practice. Noteworthy in this set of features is the central role played by the teacher in organizing, pacing, and presenting information to meet well-defined learning goals."[54]

They then examine the research findings about conceptual development and conclude that the keys are: teachers and students attending explicitly to the concepts, and students struggling with important mathematics ideas. They conclude that features of teaching that are often associated with conceptual development—use of concrete materials or higher-order questioning—are too closely tied to particular classroom conditions to make general claims about their efficacy. They also note that in many of the studies showing conceptual development, students also gained greater skill efficiency.[55]

Perhaps the most compelling evidence regarding the link between specific instructional approaches in high school mathematics and student learning is found in the Best Evidence Encyclopedia (BEE). A meta-analysis of research on middle and high school math programs examined studies with randomized or matched control groups, a study duration of at least twelve weeks, and pretest data that were roughly equal for non-randomized studies. The programs evaluated fell into three main categories: mathematics curricula, which mainly consisted of standard and alternative textbooks; computer-assisted instruction, which includ-

ed programs that used technology, such as instruction or practice on computers; and instructional process programs that focused on the use of specific instructional approaches, including cooperative learning, individualized instruction, mastery learning, and comprehensive school reform. The latter does not seem to meet the usual definition of an instructional approach as comprehensive school reform models typically include structural, programmatic, and curricular changes as well as changes in instruction.

The programs associated with the most gains in student achievement, as measured by standardized tests, were those that focused on instructional processes, particularly cooperative learning, which had a median effect size of 0.3. Those linked with the smallest gains were the mathematics curricula programs, with a median effect size of 0.07.[56]

Science

The mantra of reformers in science education is inquiry, and the past two decades have witnessed significant efforts to introduce the inquiry approach into high school science classrooms. Inquiry is built into the national science standards and used to describe good practice in the state standards for science. Inquiry is often used in other subject areas, but, like project-based learning, which might be viewed as a special form of inquiry, definitions and practices vary widely across and within subjects.[57] There is, however, a common understanding of inquiry in science because it is central to the discipline. Although pure constructivists define inquiry as an activity in which students pursue answers to questions that they generate, more typically inquiry is viewed as the conduct of investigations selected by the teacher to help students understand key concepts in the discipline. Such "guided" inquiry is featured in many of the instructional materials used in science and social studies classes and is the focus of much of the professional development provided for teachers. There is general agreement that inquiry involves active learning and should reflect what scientists actually do.

Many small studies report that open discourse helps teachers understand their students' mathematical thinking and that when students have opportunities to express their ideas, they develop greater understanding.

Researchers do not, however, agree about how effective inquiry instruction is, or which forms are most effective, or how much of it is needed. Should teachers be using pure inquiry or guided inquiry? Should they be using inquiry all of the time or only occasionally? Does inquiry work better for certain students or for certain content? And even more fundamentally, is inquiry more effective at helping students master scientific concepts and processes than more traditional forms of instruction are? With the support of the National Science Foundation, the Education Development Center undertook a rigorous review of research on the effectiveness of the inquiry approach.[58] The results of their analysis of more than 400 studies will be released in 2009, and the reader is advised to look for that report. In the interim, we must rely on other, less rigorous reviews conducted in the 1980s and 1990s that reported modest,

positive effects of inquiry on achievement, process skills, and attitudes toward science. These reviews are often cited in support of constructivist arguments that students need "hands-on" experiences in classrooms or that they need to "do" science rather than simply read textbooks, listen to lectures, or watch demonstrations. However, the development of virtual laboratories offers another, less expensive option, and raises questions about the conventional wisdom about inquiry and good science teaching. A study by David Klahr and several colleagues has found that virtual labs are a viable alternative for elementary and middle school students, although particular domains of science such as life science might require direct experience with physical objects.[59]

Reformers often connect inquiry to the use of student teams in the classroom, noting that scientists work in communities of inquiry. A review of research found that using cooperative learning in science classrooms was linked with improved student learning, as well as more positive attitudes, more engagement in tasks, and higher motivation.[60] These findings are consistent with the larger body of research on grouping or teaming discussed earlier. However, most of the science studies were small in scale; few had comparison groups, and most were in biology, so the evidence simply suggests that this approach is promising.

A study committee appointed by the National Research Council looked at the traditional laboratory activities found in high schools and concluded that labs are usually disconnected from the content of lectures. They argued for a more integrated curriculum that allows students to engage in the practices of science (for example, ask questions, make observations, analyze data, and construct explanations) and to support and deepen their understanding of science principles and concepts.[61]

The bottom line is that the evidence in support of using the inquiry approach in science is modest at best and that researchers must do more rigorous work to answer the questions raised above. Furthermore, new applications of technology are altering the meaning of inquiry and changing the debate about the reform of science instruction.

Reading and Writing

Because so many students enter high school lacking basic skills in reading and writing, these two areas have received considerable attention from researchers. Writing, in particular, has been the subject of hundreds of studies, perhaps because poor writing skills among high school graduates have been a major complaint of college faculty for decades.

Arthur Applebee and Martin Nystrand developed conceptual frameworks defining high-quality instruction in reading and writing that have guided subsequent research in this area.[62] The frameworks define quality in terms of quantity, content, coherence, and student voice. Quantity denotes the time devoted to written and oral analysis of text, the content of which must be rich enough to support sustained discussion. Coherence denotes how well lessons relate to various parts of the curriculum. Student voice refers to the use of "dialogic" instruction, with students engaging in free-flowing discussions and expressing their own ideas and questions rather than merely responding to teacher monologues or questions.[63] Nystrand reports that an observational study of twenty-five high schools found that students receiving such dialogic instruction outperformed peers receiving monologic instruction on assess-

ments in which they were asked to critique literary passages.[64] Nystrand and Adam Gamoran report similar findings from an analysis of hundreds of language arts lessons.[65] In a subsequent study of forty-four classrooms in twenty-five schools, Judith Langer found that both high-performing and low-performing students who regularly engaged in dialogic discussions outperformed peers who did not.[66]

Researchers have also carried out some big-picture studies of instruction in the language arts. Gamoran and William Carbonaro, examining data from the 1990 National Education Longitudinal Survey, found that both students and teachers reported that most students were not receiving instruction in the language arts that met the expectations of reformers in terms of the amount of time allocated, the coherence or content of the curriculum, or the opportunities for students to express themselves.[67] They also found that students in honors classes were more likely than others to receive high-quality instruction. In a related analysis of national data

Searching for Demonstration Proofs

Clearly researchers have not found compelling evidence on the effectiveness of specific instructional and organizational reforms, with the exception of the use of structured student grouping and the possible exception of dialogic or student-centered classroom discourse. But we remain persuaded that the single most important reason that high school reform efforts have failed to meet expectations is that they have failed to change classroom instructional practice. So we undertook a search for demonstration proofs—schools or districts that had made sustained gains in achievement as a result of changing instructional regimes. Could we identify schools or, even better, school districts that have undertaken systematic, sustained, and successful efforts to improve performance by altering instruction? Here we share the results of that search.

We examined data on student achievement and district instructional reform efforts for a number of sites frequently mentioned in the school reform literature, including Union City, New Jersey; Charlotte-Mecklenburg, North Carolina; Duval County, Florida; and Montgomery County Public Schools, Maryland. We also examined evidence compiled for districts that had been awarded the Broad Prize for Urban Schools and schools implementing the Talent Development and First Things First school reform models. In general, we found no solid empirical data to support conclusions regarding the positive effect of district instructional reform initiatives on student achievement. The lack of evidence results in part from measurement complications associated with the many elements involved in district and school initiatives and from using state standardized assessments of varying quality to measure the impact of district-wide initiatives. But the paucity of evidence also suggests that even districts with vision and commitment face considerable difficulties in implementing and sustaining instructional reform initiatives, particularly at the high school level. For example, schools adopting the First Things First and Talent Development programs appeared to implement structural reforms with greater ease and fidelity than the instructional changes associated with these programs. Research from other sites suggests that even districts that initially raised student achievement, such as those recognized by the Broad Foundation, did so only in the elementary and middle grades and often found it hard to sustain the improvements over time.

from the National Adult Literacy Survey, Carbonaro and Gamoran found that student voice and the content of the curriculum were related to reading achievement but that quantity of assignments and coherence of instruction were not.[68]

Researchers at Johns Hopkins University recently conducted a systematic review of evidence on the effectiveness of various approaches to teaching reading to adolescents, as well as the effectiveness of instructional materials in reading and of computerized reading programs. The biggest gains in achievement were associated with instructional process programs involving cooperative learning (a median effect size of 0.28) and for mixed-method programs, such as Read 180 and Voyager Passport, that combined large-group and small-group instruction with computer activities. No studies of reading curricula or textbooks met the criteria for the analysis.[69]

Steve Graham and Dolores Perin conducted a rigorous meta-analysis of 123 studies of instruction in writing, all of which used experimental or quasi-experimental designs.[70] The authors categorized the instructional approaches into four groups: process writing, such as writers' workshops; explicit teaching of skills, processes, or knowledge; strategies for "scaffolding" students' writing, such as pre-writing, peer assistance, and feedback; and alternative modes of composing, such as using word processing. The largest effect size (0.82) was linked with instructional approaches that explicitly taught strategies for planning, revising, and editing writing.[71] Teaching students how to summarize reading material had a similarly large effect on writing quality. Using grouping arrangements that allowed students to work together to plan, draft, revise, and edit had an effect size of 0.75.[72]

Summary

It seems clear even from this unsystematic review of the evidence that the instructional approach teachers choose matters for student learning. And interesting commonalities in the evidence across disciplines suggest the power of well-designed grouping strategies, of classroom discourse that allows students to express their ideas and questions, and of offering students challenging tasks. Some evidence also suggests that inquiry approaches may add value. But although researchers look for routines in classroom practice that are linked to achievement, teachers, who have great discretion in their choice of instructional strategies, appear to pay little heed to the evidence that researchers amass. As a consequence, less than half of American high school students report working in groups. An even smaller share reports being engaged in any inquiry.[73]

The Instructional Reforms We Need

What guidance does research offer public high schools with a pressing need to improve instruction?[74] What should they do? What should researchers, educators, and policy makers be doing to help them? The policy environment for high schools is, to say the least, demanding. Standards-based reforms are asking high schools to do something they have never before been required to do—to succeed at some significant level with substantially all students. There is a growing public consensus both that schools should take on more responsibility for equalizing student outcomes and closing "gaps" and that the outcomes for all students should be more ambitious, more "world class," more rigorous. The nation's education policies have changed dramatically in recent decades, as have the economy and societal expectations, and it is clear that instruction—teaching and

learning—has to change as well. Yet human differences being what they are, exposing all students to the same content and practice for the same amount of time will inevitably result in widely differing outcomes. For student outcomes to be more equal or, perhaps more reasonably, for substantially all students to master the core knowledge and skills needed for further education, for success in the modern economy, and for responsible civic participation, educators will have to vary the amount and nature of instruction to take account of students' differences in motivation, dispositions and aptitudes, experience, and instructional needs. At the moment, however, as the review of evidence in this article demonstrates, neither researchers nor educators have an adequate idea of how to do that. Assertions that educators and policy makers know what to do, but lack the will to do it undermine the possibility of making the needed investments in research, program development, and teacher training. As we show in this article, the educational community has a lot to learn about how to meet the standards that policy rhetoric has set. It would do everyone involved a disservice to pretend otherwise.

The point is for schools to take responsibility for each student and to try continually to do better. Schools should promote the use of proven practices such as structured student groups and dialogic discourse. But they must also adopt instructional approaches in which teachers deliberately and systematically attend to how students vary in what they are learning, regularly adapting their instruction in response to students' progress and needs, in the process learning more about what variations in instruction respond most effectively to common variations in students' learning. This approach need not lead to tracking, as some fear, but rather to real-time interventions in classrooms, regrouping within or across classrooms, or the provision of additional instruction through tutoring or supplemental experiences.

Schools should promote the use of proven practices…. But they must also adopt instructional approaches in which teachers deliberately and systematically attend to how students vary in what they are learning….

The process we are describing is sometimes known as personalization, but we prefer the term "adaptive instruction," which makes clear that the focus is instruction and not merely relationships. Adaptive instruction could incorporate the effective instructional approaches we have been reviewing, but add the power of real-time feedback and continuous improvement, for the student, for the teacher, and for the profession. Although little direct evidence supports the claim that adaptive instruction will help high schools meet the challenges of the new century, the considerable body of evidence showing that formative assessment improves student performance is relevant to our argument. Adaptive instruction is an analogue of, indeed the point of, formative assessment.[75] Teachers who use formative assessment are trying to enable their students to reach some learning goal, and they assess students regularly to see whether the students are on track to reach the goal. If the assessment indicates they are not, the teachers will use information gained

from the assessment to modify their instruction and try again to help students move toward the goal. They will then evaluate the results of their new effort and, once again, try something else if it has not been successful. This is adaptive instruction. To make sustained progress, the process must be coupled with provisions for capturing and evaluating the instructional responses to the formative feedback to build and manage knowledge about what might work in comparable situations in the future.

The evidence that formative assessment can have substantial effects on students' learning comes from studies that have focused on classroom uses in which teachers gather evidence of whether or not students are learning in the course of day-to-day, or even moment-to-moment, instruction and adapt their teaching on the basis of that evidence while the lesson or instructional unit is still in progress.[76] The evidence is often based on teachers' observations of student work, on student responses to teachers' questions, or on the use of techniques that allow students to give continual feedback about whether they understand the material. In some cases, researchers have used more formal assessment tools but in this short-term way. This work, and earlier studies of mastery learning, has its roots in evidence that one-on-one tutoring has large effects on learning—on the order of 2.0 (two standard deviations). Indeed, both formative assessment and adaptive instruction can be viewed as attempts to replicate at the classroom level the responsiveness of individual tutoring.[77] The studies cited in support of these approaches typically were small in scale, and as yet no studies have been conducted of similar interventions that try to use these classroom-level approaches at scale in whole school systems or that try to encourage the adaptation of instruction based on evidence of students' performance and progress gathered during longer cycles of instruction, such as with the interim assessments that have become so popular.

It is important to recognize that what is being "adapted" in adaptive instruction is not the learning goals for students, but rather the instructional strategies and supports offered to help students reach the goals. This instructional approach is consistent with both standards-based education and outcomes-based accountability. It also goes to the heart of the difference between the earlier conceptions of opportunity to learn based on equity in exposure to content and the newer conceptions based on ensuring greater equity in outcomes. Achieving the latter will require appropriate adaptations in the interaction between teacher and student to ensure that learning progresses. This view of instruction in a standards-based environment stands in sharp contrast to some contemporary conceptions of content standards, particularly grade-by-grade content standards that all students are supposed to meet at the same time, supported by pacing guides and interim assessments. Instead, it recognizes and accepts that students may vary greatly in their rate of progress toward the standards and in the kinds of instructional support they need to meet them.

The wide variation in instructional practices within and across schools in systems has led some policy makers to seek more control over instruction to ensure that students experience a common curriculum. By adopting district-wide curricular materials, curricular roadmaps, pacing guides, and similar tools, policy makers aim to provide greater quality control over teachers' practice and to make teaching more uniform across systems. But these management tools work at cross-purposes

with the use of adaptive instruction, which requires variations in instructional strategies and pacing and even in the micro-content of the curriculum. If policy makers want to encourage adaptive instruction, they must take a different approach to quality control and design a set of tools that focuses on teachers' use of formative assessment, selection of appropriate responses, and progress toward raising performance and closing gaps. Policy makers must make greater investments in building strong communities of practice, supervision, knowledge management, and coaching, and less in standardizing the instructional process.

Given the rather weak knowledge base on instruction and given today's policy environment, we believe that making such investments would put the nation's high schools on the path toward improving instruction and meeting the challenges they face. But we recognize that the evidence supporting our arguments is thin and that competing theories about how to improve instruction also deserve attention and testing.

We further recognize that persuading teachers to use adaptive instruction will be difficult and will require the development of easy-to-use instructional materials and assessment tools designed to support this approach. Monitoring individual progress and providing appropriate instructional responses will be more difficult in high schools than in elementary schools given the number of students the typical teacher works with each day and the complexity of the curriculum, but new applications of technology such as the hand-helds being used to track students in elementary classrooms and the cognitive tutors widely used to supplement classroom instruction in colleges might be adapted for use in high schools and make the work manageable.

Many teachers will want to hold on to the old norms of coverage and selection, but faced with growing pressures to serve all students and evidence that their peers are making progress toward this goal by embracing adaptive instruction (or other instructional approaches that prove to be robust), we believe they also will change their practice as most teachers want their students to succeed.

What Next?

Clearly, the instructional approach that teachers and their schools adopt matters for students' learning. The proven effectiveness of such instructional approaches as group learning makes one wonder why well-designed student groups in writing, science, and mathematics are not a major focus of teacher training, professional development, and teacher evaluation. Use of student teams or cooperative groups should be the norm rather than the exception in the classroom. Likewise, it should be the norm to use discussion strategies that allow student voices to be heard. Vigorously pursuing these and all other promising instructional strategies can contribute not only to student learning but also to increased collaboration and shared knowledge among teachers and to stronger norms of responsibility for learning and shared norms of good practice. Researchers are beginning to uncover some starting points for building evidence-based instructional practice, practice supported by new tools and materials that embed sound theory and make creative use of new technologies that have been tested and found effective.

But there are major gaps in the knowledge base, and the evidence for the effectiveness of instructional approaches is limited and uneven. The studies that identify classroom routines associated with increased student learning tend to be observational and quali-

tative, and the samples tend to be small. Although such studies can help build theories that inform practice, they do not have the kind of rigor that generates evidence with a warrant to prescribe practice. Conversely, studies that try to link teaching practices to outcomes often rely on teacher self-reports or crude measures of practice and narrow measures of student achievement such as standardized tests that do not begin to assess more complex cognitive goals. The evidence problem must be addressed. Better theories of instruction, better measures of practice, and more rigorous studies of the effects of particular instructional approaches or routines are essential. Once they are available, it will be possible to begin to build a body of knowledge about instruction that can compel the profession to attend to its implications for teaching.

Researchers must design experiments to test various instructional approaches being used in combination with the curriculum, materials, and assessment tools meant to be used with them. They must also devise technology that makes it easier for teachers to use labor-intensive approaches, like adaptive instruction or project learning, as well as tools to simplify, standardize, and increase the efficacy of these approaches. Finally, they must build a culture of evidence in education that supports the spread of instructional practices that produce large effects.

We believe that a research and development program that emphasizes adaptive instruction is essential as it has the greatest potential for improving the efficacy of instruction in today's standards-based policy environment. New applications of technology are making adaptive instruction feasible even in situations where teachers have to deal with large numbers of students, and applications of cognitive science to the development of online learning opportunities such as Cognitive Tutor, Simcalc, Agile Mind, Mastering Physics, and other similar programs may redefine and enhance the power of adaptive instruction. Admittedly, the evidence supporting the effectiveness of adaptive instruction is weak at this point, but the theoretical argument is persuasive, and we believe adaptive instruction can be combined with student teaming, discussion methods, and even project-based learning to create more powerful pedagogies. Because the evidence is weak, however, other approaches should be developed and tested as well.

We end this essay on an optimistic note. The body of knowledge about what instructional practices work is growing. There are signs that an evidence-based culture is developing in the profession and in school districts. New technologies are being developed, and more importantly used, in classrooms. Many gaps remain in the profession's knowledge about teaching and learning, especially in high schools, but we see a bit of light at the end of the tunnel, and we think that a major national research and development effort can move the education community toward the light.

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77. See, for example, P. A. Cohen and others, "Educational Outcomes of Tutoring: A Meta-Analysis of Findings," *American Educational Research Journal* 19 (1982): 237–48.